INVESTIGATION OF THE FUEL TEMPERATURE COEFFICIENT OF INNOVATIVE FUEL TYPES

Jan Leen Kloosterman
Interfaculty Reactor Institute
Delft University of Technology
Mekelweg 15, NL-2629 JB Delft
E-Mail: J.L.Kloosterman@iri.tudelft.nl

And

Rudy J.M. Konings
Netherlands Energy Research Foundation (ECN)
P.O. Box 1, NL-1755 ZG Petten
E-Mail: Konings@ecn.nl

Abstract

The fuel temperature coefficient has been calculated for several fuel types designed for the transmutation of plutonium, ranging from standard (U, Pu) MOX fuel to innovative fuel types based on plutonium oxide mixed in an inert matrix. For all fuel types, the fuel temperature coefficient is large in magnitude and negative. For the fuels containing uranium or thorium oxide, a large contribution to the FTC is due to the $^{238}$U or $^{232}$Th (about $-2.2$ pcm/K). In addition, quite a large contribution is present due to the $^{240}$Pu (about $-1$ pcm/K), while the contribution due to $^{242}$Pu is not larger than $0.3$ pcm/K in magnitude. When the moderator-to-fuel volume ratio of (U, Pu) MOX fuel is enlarged from 2 to 4, the FTC decreases in magnitude due to a better thermalization of the neutron spectrum and a correspondingly larger resonance escape probability.

When the fuel matrix is made of a neutron inert material, only the plutonium isotopes contribute to the FTC. For reactor grade plutonium, $^{240}$Pu contributes about $-1$ pcm/k, while $^{242}$Pu contributes $-0.3$ pcm/K. The odd fissile plutonium isotopes give either a positive or negative contribution to the FTC, dependent on the composition of the matrix. In case of weapons grade plutonium mixed in an inert matrix, the FTC ranges up to $-1$ pcm/K. Further research should assess the feasibility of such fuels based on thermal considerations.